CAUCASIANA
Journal on the biodiversity of the Caucasus and the adjacent regions

Caucasiana 3: 245–256 (2024)
DOI: 10.3897/caucasiana.3.e132243

Research Article

Gastrointestinal helminths of small mammals (Rodentia and Carnivora) in the vicinity of Usholta, Georgia

Ketevan Nikolaishvili[1], Tsitsino Lomidze[1], Lela Arabuli[1], Ketevan Asatiani[1], Lali Murvanidze[1]

1 *Institute of Zoology, Ilia State University, Tbilis, Georgia*

Corresponding author: Tsitsino Lomidze (tsitsino.lomidze@iliauni.edu.ge)

Abstract

In this study, we investigated the gastrointestinal helminth fauna of small mammals in the highland region of Usholta (Racha, Western Georgia). In total, 19 specimens of small mammals were examined, of which 10 gastrointestinal helminth species were detected. Five out of eight specimens of *Apodemus uralensis* were infected with three nematode species: *Heligmosomoides polygyrus*, *Syphacia obvelata*, and *Trichuris muris*. Notably, the liver of a single individual of *A. uralensis* was also infected with cestode—*Echinococcus multilocularis*, (larvocysts) —a novel host record for this parasite in Georgia. All eight exeminated *Microtus daghestanicus* specimens were infected with both cestode (*Paranoplocephala omphalodes* and *Rodentolepis asymmetrica*) and nematode (*Heligmosomum costellatum* and *Syphacia* sp.) parasites. Similarly, all three exeminied specimens of *Mustela nivalis* were infected with cestodes (*Versteria mustelae*) and nematodes (*Molineus patens*, *Syphacia* sp.). For *Syphacia* sp., *M. nivalis* is a new host record in Georgia. Only one specimen of *A. uralensis* was simultaneously infected by two species of nematodes (*Syphacia* sp., *T. muris*) and also a single individual of *M. nivalis* was infected with three species of helminths (*V. mustelae*, *M. patens*, *Syphacia* sp.). This study provides valuable insights into the helminth diversity and host-parasite relationships in the region, highlighting the importance of continued research on wildlife parasites.

Key words: Caucasus, Cestoda, host, life cycle, Nematoda, parasite

OPEN ACCESS

Academic editor: Anna Faltynkova
Received: 16 July 2024
Accepted: 11 October 2024
Published: 11 December 2024

ZooBank: https://zoobank.org/0A8DC0C5-2400-4EA3-874B-4D23E69AD5F6

Citation: Nikolaishvili K, Lomidze T, Arabuli L, Asatiani K, Murvanidze L (2024) Gastrointestinal helminths of small mammals (Rodentia and Carnivora) in the vicinity of Usholta, Georgia. Caucasiana 3: 245–256. https://doi.org/10.3897/caucasiana.3.e132243

Copyright: © Nikolaishvili et al.
This is an open access article distributed under terms of the Creative Commons Attribution License (Attribution 4.0 International – CC BY 4.0).

Introduction

Gastrointestinal helminths (GH) are one of the main groups of parasites found in small mammals and represent a significant economic concern, causing parasitic diseases in humans and animals (Han et al. 2015; Ranjbar et al. 2017). Good knowledge on the distribution and diversity of GH, their hosts, host-parasite interactions, and the possible ways of transmission to humans and livestock is crucially important for the prevention of parasitic diseases (Hamzavi et al. 2024). Additionally, GH represent a significant part of biodiversity, and their role in ecosystem functioning cannot be underestimated. Thus, acquiring the primary data on GH diversity and their hosts at a local to global scale is of primary importance (Aloyan 1956; Shakhtakhtinskaya et al. 1970; Manasyan 1985; Shimalov and Shimalov 2001; Nakao et al. 2010; Miller et al. 2016; Lucio et al. 2021; Khan et al. 2022; Haukisalmi et al. 2024; Kirillova et al. 2024). In Georgia, the study on the GH of small mammals was conducted in the second

half of the last century by Kirshenblat (1948), Rodonaia (1951, 1966, 1971), Matsaberidze (1966a, 1976), and Kurashvili et al. (1989). In the recent years, only a single paper was published reporting the infestation of mole-rat *Nannospalax xanthodon* by a cestode — *Paranoplocephala* (Nikolaishvili et al. 2022). Thus, the data on the diversity of GH of small mammals in Georgia is scarce.

The vicinity of Usholta (Racha-Lechkhumi-Lower Svaneti region) is one of the unexplored parts of the Georgian highlands in terms of GH. The aim of this research is to study the GH fauna of small mammals and find out possible ecological connections between the identified parasites and their hosts in a given geographical locality.

Materials and methods

Study area

Usholta (N42°29'59", E43°24'07") and its surroundings are located within the Oni Municipality in Western Georgia on the border of forest and subalpine landscape zones (Ukleba 1981) (Fig. 1 A, B). The region is rich with fauna, with records of around 42 species of mammals (Bukhnikashvili et al. 2023).

Examination of small mammals for helminthes

A total of 19 specimens of small mammals were collected in 2022, including eight specimens of lesser wood mice *Apodemus uralensis* (family Muridae), eight specimens of Daghestan voles *Microtus daghestanicus* (family Cricetidae), and three specimens of common weasels *Mustela nivalis* (family Mustelidae). For each specimen, the gastrointestinal tract and related organs were examined for GH. To assess the species diversity of the host helminth fauna and their infestation rates, wherever possible, the following parasitological indicators (the prevalence; mI—mean intensity of infestation (specimen); the R—parasitation range; mA—mean abundance) were calculated according to Bush et al. (1997), Anikanova et al. (2007), and Dege et al. (2019). The cestodes were washed in water and fixed in 70° alcohol; a glycerin and lactic acid equal mixture was used to achieve the temporary transparency of the samples. Permanent preparations were stained in aceto-carmine, dehydrated in an ascending alcohol series, and mounted in Canada balsam (Fried and Manger 1992). The nematodes were washed in water and fixed in 70° alcohol, and lactic acid and glycerin in equal volumes were used for transparency. A morphological and morphometric study of the material was carried out using a stereomicroscope (Omax AC 100-240 V) with dual lights and a 10 MP USB digital camera. Helminths were identified according to key features (Abuladze 1964; Matsaberidze 1976; Ryzhikov et al. 1978, 1979; Kurashvili et al. 1989). The material is stored in the collection of the Institute of Zoology, Ilia State University.

Results

Five out of eight specimens of *Apodemus uralensis* were infected with one or more helmints, while maximum infestation was observed in *Microtus daghestanicus* (all eight specimens) and three *Mustela nivalis* (all three specimens).

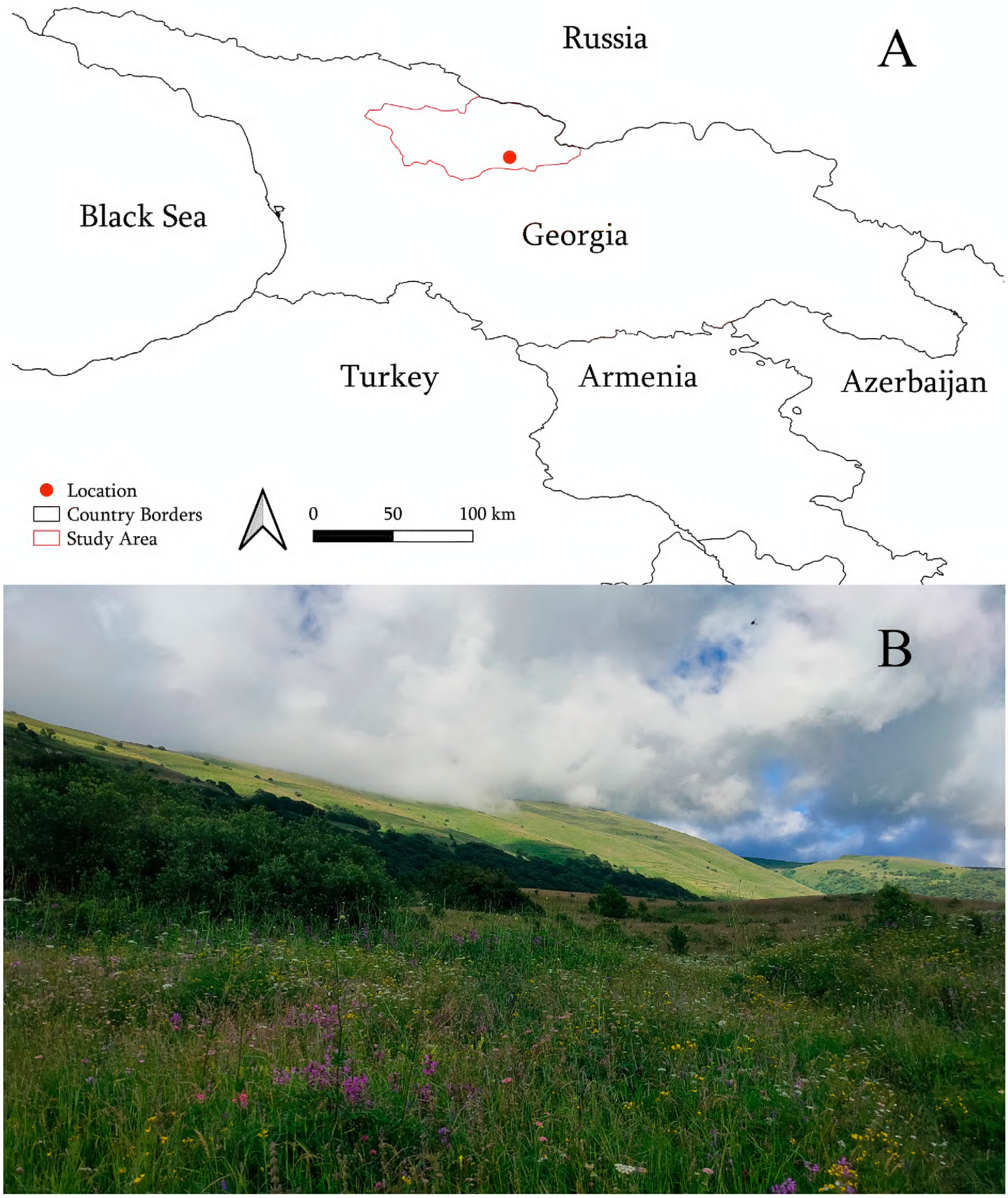

Figure 1. Map (**A**) and the view (**B**) of Usholta area, Georgia.

Ten species of GH (Cestoda and Nematoda) were recorded. There were 4 species of cestodes: *Paranoplocephala omphalodes* (Hermann, 1783) (Anoplocephalidae), *Versteria mustelae* (Gmelin, 1790) = (*Taenia tenuicollis* = *Taenia mustelae*), *Echinococcus* (=*Alveococcus*) *multilocularis*, larvae (Leuckart, 1863) (Taeniidae), and *Rodentolepis asymmetrica* (Janicki, 1904) (Hymenolepididae); six species of nematodes: *Heligmosomoides polygyrus* (Dujardin, 1845), *Heligmosomum costellatum* (Dujardin, 1845) (Heligmosomidae), *Syphacia obvela-*

ta (Rudolphi, 1802), *Syphacia* sp. (Oxyuridae), *Trichuris muris* (Schrank, 1788) (Trichuridae), *Molineus patens* (Dujardin, 1845) (Molineidae) (Table 1).

The prevalence, infestation intensity, infestation ranges, and mean abundance of parasites are given in Table 2. Noteworthy, *Syphacia* sp. and *M. patens* have the highest prevalence in *M. nivalis* (both with prevalence 2/3), followed by *H. polygyrus* in *A. uralensis* and *R. asymmetrica* in *M. daghestanicus*, both with prevalence 3/8. The rest of the helminths have been detected only in single-host specimens. It was noted that one *A. uralensis* had numerous larvocysts of *E. multilocularis* on the liver (around 60 vesicles 1-3 mm in size) (Fig. 2; Table 2). Only one specimen of *A. uralensis* was simultaneously infected by two species of nematodes (*Syphacia* sp., *T. muris*), and also a single individual of *M. nivalis* was infected with three species of helminths (*V.* mustelae, *M. patens*, and *Syphacia* sp.).

Table 1. Distribution of cestodes and nematodes in small mammals in the vicinity of Usholta.

Gastrointestinal helmints	Hosts		
	Apodemus uralensis	***Microtus daghestanicus***	***Mustela nivalis***
Cestoda			
Paranoplocephala omphalodes		+	
Versteria mustelae			+
Rodentolepis asymmetrica		+	
Echinococcus multilocularis, larvae	+		
Nematoda			
Heligmosomoides polygyrus	+		
Heligmosomum costellatum		+	
Syphacia obvelata	+		
Syphacia sp.		+	+
Trichuris muris	+		
Molineus patens			+

Discussion

The overall infection rate with gastrointestinal helminths in 19 examined animals was quite high – 84.2%, despite the fact that in the vicinity of Usholta, the summer period (July 2022) was characterized by a low number of rodents and a limited species composition (personal note by A. Bukhnikashvili). *Microtus daghestanicus* and *Mustela nivalis* stood out with a higher infestation rate. Ten species of helminths were identified in the examined small mammals. Various environmental factors (type of food, soil-related lifestyle, and others) are supposedly involved in the formation of the helminth fauna of rodents, which act as definitive, intermediate, and reservoir hosts of helminths and are vectors of a number of zoonotic diseases (Kurashvili 1961; Matsaberidze 1966a, 1976; Kennedy 1978; Kirillova and Kirillov 2008; Ranjbar et al. 2017; Lucio et al. 2021; Khan et al. 2022; Jouet et al., 2023).

The infection rate of *Apodemus uralensis* was 5/8. Similarly, Matsaberidze (1966a) indicates the infestation of wood mice in eastern Georgia at 57%. In the vicinity of Usholta, *A. uralensis* was not distinguished by the species diversity of helminths, especially cestodes. Manasyan (1985) explains the presence of a small number of cestode species in wood mice *A. sylvaticus* in Armenia by

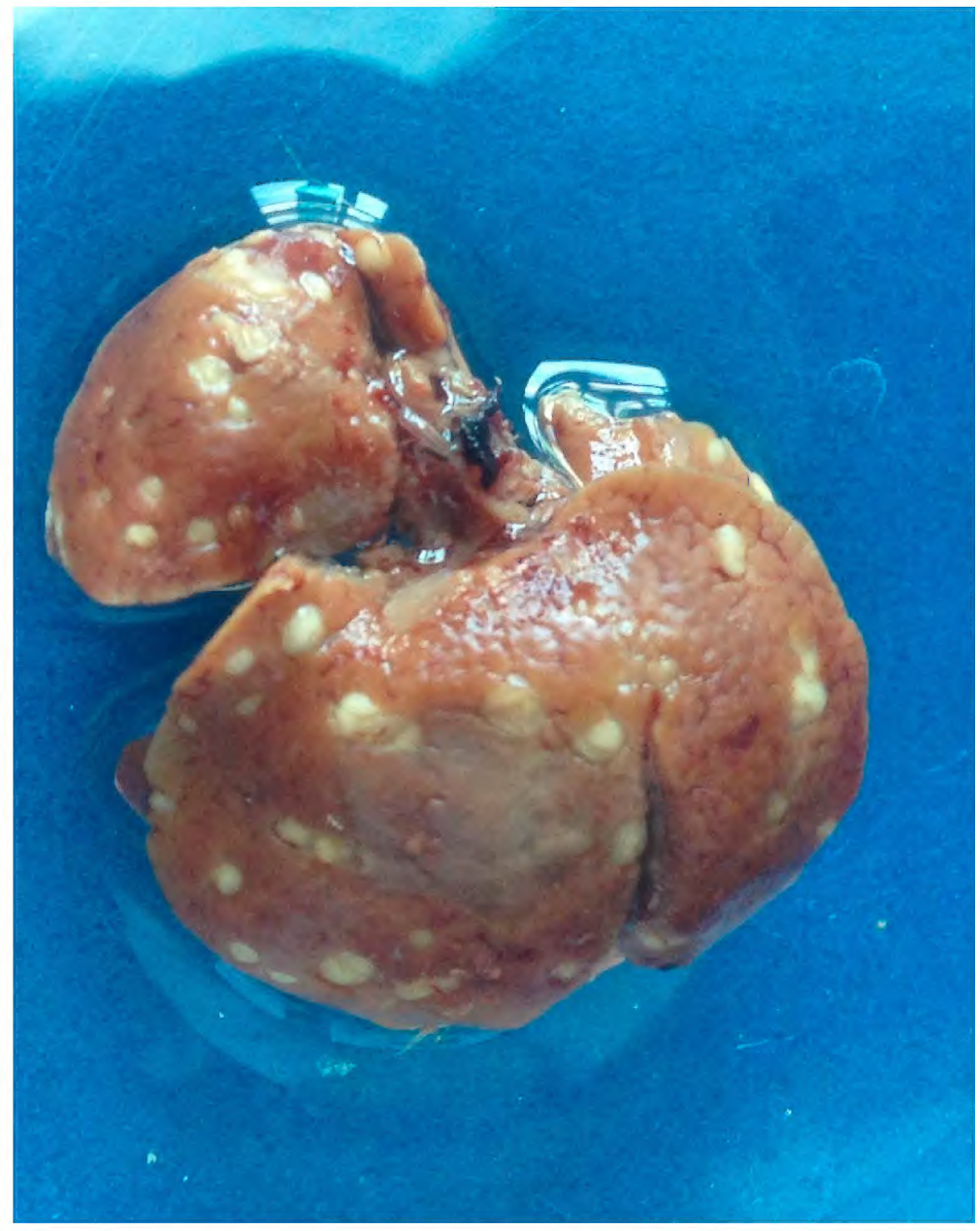

Figure 2. *Echinococcus multilocularis,* larvocysts in *Apodemus uralensis* collected in Usholta, Georgia.

the predominance of green food in nutrition. This limits the possibility of eating intermediate hosts of cestodes. We agree with the conclusion of Manasyan (1985), and the presence of *Echinococcus multilocularis* larvae in the liver of *A. uralensis* as an intermediate host is most probably due to local environmental conditions and food sources. It should be noted that the larval stage of *Echinococcus* differs from the strobilar stage in its wide distribution and exceptional pathogenicity (Ginetsinskaya and Dobrovolsky 1978).

Mouse-like rodents, usually voles, serve as the main intermediate hosts of *E. multilocularis* larvae (Kirillova and Kirillov 2008; Nakao et al. 2010; Miller et al. 2016). In Georgia, the first occurrence of the larval form of *Echinococcus* in the social vole *Microtus socialis* was registered by Kurashvili (1961). Then Matsaberidze (1966, 1966a, 1976) discovered it in the liver of the mountain voles *M. roberti* in the forest, subalpine, and alpine zones of Eastern Georgia. There is data in the literature where, along with voles, different species of wood mice were studied on *E. multilocularis* (Stieger et al. 2002; Barabási et al. 2011; Miller et al. 2016). Kirillova and Kirillov (2008) found *E. multilocularis* larvae in the liver of both the common vole *M. arvalis* and the field mouse *A. agrarius* on the territory of the Mordovinsk floodplain of Samarskaya Luka (Russia). The infestation rate was 1.3% for *M. arvalis* and 1.2% for *A. agrarius* (Kirillov and Kirillova 2017). Larvocysts of *E. multilocularis* have not been found in the genus *Apodemus* in Georgia. According to our data, *A. uralensis* in the vicinity of Usholta turned out to be a new host of *E. multilocularis* in Georgia. This fact deserves attention; it

Table 2. Qualitative and quantitative helminths structure of the small mammals (Rodentia and Carnivora) in the vicinity of Usholta (Georgia). N – number of parasitized hosts; P – prevalence; R – parasititation range; mI – mean intensity; mA – mean abundance.

Helminths	Hosts														
	***Apodemus uralensis* (n=8)**					***Microtus daghestanicus* (n=8)**					***Mustela nivalis* (n=3)**				
	N	**P**	**R**	**mI**	**mA**	**N**	**P**	**R**	**mI**	**mA**	**N**	**P**	**R**	**mI**	**mA**
Cestoda															
Paranoplocephala omphalodes	–	–	–	–	–	1	1/8	1	1	0.125	–	–	–	–	–
Versteria mustelae	–	–	–	–	–	–	–	–	–	–	1	1/3	3	3	1
Rodentolepis asymmetrica	–	–	–	–	–	3	3/8	1–4	2.0	0.75	–	–	–	–	–
Alveococcus multilocularis, larvae	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nematoda															
Heligmosomoides polygyrus	3	3/8	3–39	18	6.75	–	–	–	–	–	–	–	–	–	–
Heligmosomum costellatum	–	–	–	–	–	1	1/8	2.0	2.0	0.25	–	–	–	–	–
Syphacia obvelata	1	1/8	66	66	8.25	–	–	–	–	–	–	–	–	–	–
Syphacia sp.	–	–	–	–	–	1	1/8	158	158	19.75	2	2/3	10–17	13.5	9
Trichuris muris	1	1/8	2.0	2.0	0.25	–	–	–	–	–	–	–	–	–	–
Molineus patens	–	–	–	–	–	–	–	–	–	–	2	2/3	1–18	9.5	6.33

allows us to predict the spread of such a dangerous helminth, both among the known intermediate hosts inhabiting this zone – from Rodentia, and for its final hosts – Canidae.

Nematodes in *A. uralensis* are presented with three species: *Heligmosomoides polygyrus* (Dujardin, 1845), *Trichuris muris* (Schrank, 1788), and *Syphacia obvelata* (Rudolphi, 1802) (Tables 1 and 2). They are obligate widespread parasites of rodents and were recorded in different regions of Georgia by Kirshenblat (1938, 1948), Matsaberidze (1966, 1966a), and in the adjacent republics of the South Caucasus (Aloyan 1956; Shakhtakhtinskaya et al. 1970; Manasyan 1985). According to Matsaberidze (1976), *H. polygyrus* in Georgia was found in wood mice (4.2%) in the zone of steppes and semi-desert vegetation. In the vicinity of Usholta, *H. polygyrus* turned out to be the dominant nematode with a prevalence of 3/8. *T. muris* is a rather widespread parasite. Infestation varies in a wide range. It most often infected wood mice in Georgia (Kirshenblat 1938, 1948; Rodonaia 1956, 1966; Matsaberidze 1966, 1966a, 1976; Kurashvili et al. 1989). Matsaberidze (1966) recorded it in forest, subalpine, and alpine zones. In our study area, two specimens of *T. muris* were found in only one *A. uralensis* and had the lowest mA (0.25) compared to *H. polygyrus* (mA = 6.75) and *S. obvelata* (mA = 8.25) (Table 2). Sixty-six specimens of the latter were found in the cecum of one individual of *A. uralensis*. A similar abundance (1-300) of *S. obvelata* in the gastrointestinal tract of rodents was recorded by Matsaberidze (1966a) in the forest, subalpine, and alpine zones of Eastern Georgia, to which our data fits well.

From cestodes, *Paranoplocephala omphalodes* and *Rodentolepis asymmetrica* were detected in *M. daghestanicus*, with much higher prevalence of the latter. These species of cestodes were discovered by Kirshenblat (1948) in the Daghestan vole in the forest zone at 1040 m a.s.l. (village Ermani, Dzhava region). Both cestodes are obligate parasites of rodents (Kurashvili et al. 1989) and were recorded several times in Transcaucasia (Kirshenblat 1948; Akhu-

myan 1956; Matsaberidze 1966a, 1976; Tarzhimanova 1970). In Georgia, these helminths are revealed in *Microtus arvalis*, *M. socialis goriensis*, *Pitymys majori*, and *Chionomys roberti* on the northern slopes of the Trialeti Range. According to Kirshenblat (1938, 1948), *P. omphalodes* is distributed mainly in alpine meadows, in the high-mountain steppe, and in forest zones. Matsaberidze (1966a) found *P. omphalodes* both in the zone of steppes and semi-desert vegetation and in forest, subalpine, and alpine zones, where armored and thyroglyphoid mites (participating in the biological cycle of helminth development) are widely represented. As noted by Kirillova and Kirillov (2008), infection with most adult forms of cestodes, including *P. omphalodes*, occurs through accidental eating, along with grassy food or digging holes, of small invertebrates (soil mites, springtails) – intermediate hosts of helminths. We discovered *P. omphalodes* at the border of the forest and subalps in the vicinity of Usholta. Since *M. daghestanicus* is an herbivore that mainly eats any part of the plants above the soil, we believe that a similar process of feeding and invasion occurs in the case of *P. omphalodes*.

A single species of cestode, *Versteria mustelae*, was found in *M. nivalis* in the area around Usholta. *M. nivalis* is widely distributed in the forest and subalpine landscape zones of Georgia, reaching a height of up to 3000 m a.s.l. (Janashvili 1963; Shidlovsky 1964). In *M. nivalis* studied in various regions of Georgia, Rodonaia (1951) discovered the cestode *Taenia* sp. in *M. nivalis*, and based on the descriptions of Petrov (1941) and Abuladze (1964), it was classified by her as a species – *Taenia tenuicollis* (now a synonym of *V. mustelae*) (Rodonaia 1971). Bagnato et al. (2022) believe that all new species of the genus *Versteria* are potential "zoonotics". We also consider that the cestode *V. mustelae*, which we found in *M. nivalis* in the vicinity of Usholta, can also become a source of zoonotic invasion in the wild.

Nematodes *Syphacia* sp. and *Molineus patens* were also represented in *M. nivalis*. *Syphacia* sp. in the intestinal tract of *M. nivalis* was discovered for the first time in Georgia. It is noteworthy that in each group of studied animals, including the *M. nivalis*, nematodes of the genus *Syphacia* were found with a high mean intensity of invasion and in an abundance. Nematodes of this genus often parasitize different species of rodents in various parts of the intestinal tract (Kirshenblat 1948; Matsaberidze 1976). *Syphacia* sp. are strict-specific parasites', most of them host-specific at the genus level (Vlasov et al. 2015). An explanation for the fact revealed above was found in the work of Varodi et al. (2017), in which the presence of rodent nematodes *Syphacia arvicola* and *Heligmosomoides* sp. in the intestinal tract of mustelids was usually observed in studies of this host group. The authors discovered a fairly diverse community of nematode species acquired by weasels from rodents and considered post-cyclic parasitism. Helminthological examinations of mustelid carcasses (ermine and weasels) conducted in Belarus (Shimalov and Shimalov 2001) revealed a high total (78.7%) infestation of these animals with 20 species of helminths.

According to the literature data, *M. patens* is a very specific parasite of Carnivora and is widespread in Mustelidae (Varodi et al. 2017; Pavlović et al. 2021), which is also commonly detected in *M. nivalis* in Georgia (Rodonaia 1951, 1956, 1966, and 1971).

Despite the low number and species composition of studied small mammals in the vicinity of Usholta, we identified a noticeably high overall infestation of GH. At the same time, the mean intensity of invasion was relatively small. Such a ratio of these parameters indicates that in this parasitologically unexplored region, the basic conditions for the functioning of the "parasite-host" system are preserved, and this data agrees with the findings previously obtained in different regions of Georgia (Kirshenblat 1948; Matsaberidze 1976; Rodonaia 1971). The formation of micromammal helminth fauna in the vicinity of Usholta is connected with the local ecosystem, which includes a complex of biotic and abiotic factors. New data on the study of GH of small mammals in the vicinity of Usholta will supplement the existing material on the biodiversity of helminth fauna and expand the knowledge on their distribution and host specificity in Georgia.

Acknowledgements

We express their gratitude to the staff of the Institute of Zoology at the Ilia State University, Dr. Alexander Bukhnikashvili, for the identification of hosts and photos, as well as laboratory assistant Giorgi Sheklashvili for collecting small mammals and Ani Bikashvili for map design. We are also indebted to the reviewers, Anna Faltynkova and Levan Mumladze (editors), for their extensive help in the improvement of the manuscript.

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Funding

No funding was reported.

Author contributions

All authors have contributed equally.

Author ORCIDs

Ketevan Nikolaishvili https://orcid.org/0000-0001-9627-3916
Tsitsino Lomidze https://orcid.org/0000-0002-3321-1088
Lela Arabuli https://orcid.org/0000-0001-9921-6343
Ketevan Asatiani https://orcid.org/0000-0002-7357-9434
Lali Murvanidze https://orcid.org/0000-0001-6516-2762

Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

References

Abuladze KI (1964) Taeniidae – cestodes of animals and humans and the diseases they provoke. Basics of Cestodology. Academy of Sciences of the USSR, Moscow, 530 pp. [In Russian]

Akhumyan KS (1956) To the study of the fauna of rodent cestodes in Armenia. Materials on the study of the fauna of the Armenian SSR. Zoological collection 9: 141–223. [In Russian]

Aloyan MT (1956) Nematodes of rodents of Armenia. Materials on the study of the fauna of the Armenian SSR, II, 125–170. [In Russian]

Anikanova VS, Bugmyrin SV, Ieshko EP (2007) Methods for collecting and studying helminthes of small mammals. Karelian Center of the Russian Academy of Sciences, Institute of Biology, Petrozavodsk, 145 pp. [In Russian]

Bagnato E, Gilerdoni C, Martin GM, Digiani MC (2022) A new species of *Versteria* (Cestoda: Taeniidae) parasitizing *Galictis cuja* (Carnivora: Musrelidae) from Patagonia, Argentina: Morphological and molecular characterization. International Journal for Parasitology: Parasites and Wildlife. 19: 68–77. https://doi.org/10.1016/j.ijppaw.2022.07.007

Barabási SS, Marosföi L, Barabási ZS, Cozma V (2011) Natural alveolar' echinococcosis with *Echinococcus multilocularis* in wild rodents. Scientia Parasitologica 12(1): 11-21.

Bukhnikashvili A, Kandaurov A, Sheklashvili G, Natradze I (2023) All records of rodents (Mammalia, Rodentia) and hares (Mammalia, Lagomorpha) in Georgia from 1855 through to 2022. Biodiversity Data Journal 11: e108740. https://doi.org/10.3897/BDJ.11.e108740

Bush AO, Lafferty KD, Lotz JM, Shostak AW (1997) Parasitology meets ecology on its own terms: Margolis et al. revisited. Journal of Parasitology 83(4):575–583. https://doi.org/10.2307/3284227

Dege JE, Starikov VP, Jodvirshis SV, Nakonechny NV (2019) Helminthofauna of micromammal population of Surgut and its immediate surroundings in winter period. In: Gazia GV, Kukurichkin GM, Makarov PN, Tsiro LB (Eds) Safe North – clean Arctic, Collection of articles of the II All-Russian Scientific and Practical Conference, Surgut (Russia), October 2019, Surgut State University, 154–166. [In Russian]

Fried B, Manger PM (1992) Use of an aceto-carmine procedure to examine the excysted metacercariae of *Echinostoma caproni* and *E. trivolvis*. Journal of Helminthology 66(3): 238–240. https://doi.org/10.1017/SOO22149XOOO14620

Ginetsinskaya TA, Dobrovolsky AA (1978) Private parasitology. Parasitic worms, molluscs, arthropods. High School, Moscow, 292 pp. [In Russian]

Han BA, Schmidt JP, Bowden SE, Drake JM (2015) Rodent reservoirs of future zoonotic diseases. PNAS 112(22): 7039–7044. https://doi.org/10.1073/pnas.1501598112

Hamzavi Y, Khodayari MT, Davari A, Shiee MR, Karamati SA, Raeghi S, Jabarmanesh H, Bashiri H, Bozorgomid A (2024) A systematic review and meta-analysis on prevalence of gastrointestinal helminthic infections in rodents of Iran: An emphasis on zoonotic aspects. Heliyon 10(11):e31955. https://doi.org/10.1016/j.heliyon.2024.e31955

Haukisalmi V, Ribas A, Hugot J, Morand S, Chaisiri K, Junker K, Henttonen H (2024) Phylogenetic relationships and systematics of tapeworms of the family Davaineidae (Cestoda, Cyclophyllidea), with emphasis on species in rodents. Folia Parasitologica 71: 1–11. https://doi.org/10.14411/fp.2024.011

Janashvili AG (1963) The Vertebrates of Georgia, Vol.3. Georgian Academy of Sciences, Tbilisi, 460 pp. [In Georgian]

Jouet D, Snæpórsson A, Skirnisson K (2023) Wood mouse (*Apodemus sylvaticus* L.) as intermediate host for *Mesocestoides canislagopodis* (Rudolphi, 1810) (Krabbe 1865) in Iceland. Parasitology research 122(9): 2119–2134. https://doi.org/10.1007/s00436-023-07911-6

Kennedy C (1978) Ecological Parasitology. Mir, Moscow, 224pp. [In Russian]

Khan W, Nisa NN, Perez S, Ahmed S, Ahmed MS, Alfarraj S, Ali A, Tahreem S (2022) Occurrence of *Hymenolepis diminuta*: a potential helminth of zoonotic importance of murid rodents. Brazilian Journal of Biology 82: e242089. https://doi.org/10.1590/1519-6984.242089

Kirillova NY, Kirillov AA (2008) Ecological analisis (Cestoda) of mouse-like rodents of Samarskaya Luka. Volga region ecological journal 1: 20–28. [In Russian]

Kirillov AA, Kirillova NYu (2017) Overview of cestodes of land vertebrates of the Samarskaya Luka. Proceedings of the Samara Scientific center of the Russian Academy of Sciences 19 (2): 29–36. [In Russian]

Kirillova NYu, Kirillov AA, Ruchin AB, Fayzulin AI (2024) Diversity of helminths of Insectivorous Mammals (Mammalia: Eulipothyphla) from Large Forest Protected Areas of the Middle Volga Region (European Russia). Diversity 16(5): 307. https://doi.org/10.3390/d16050307

Kirshenblat JD (1938) Patterns of dynamics of the parasitic fauna of mouse-like rodents. Leningrad State University, Leningrad, 92 pp. [In Russian]

Kirshenblat JD (1948) Materials on the helminth fauna rodents of Georgia. Proceedings of the Zoological Institute of the Academy of Sciences of GSSR 8: 217–339. [In Russian]

Kurashvili BE (1961) On the role of the voles and the Transcaucasian steppe fox in the epidemiology and epizootiology of alveolar echinococcus in Eastern Georgia. Bulletin of the Academy of Sciences of the Georgian SSR 26(3): 309–315. [In Georgian]

Kurashvili BE, Matsaberidze GV, Sadikhov IA, Rodonaia TE (1989) Parasitic worms of small mammals of the Transcaucasian fauna. Metsniereba, Tbilisi, 197 pp. [In Russian]

Lucio C, Gentile R, Cardoso T, Santos F, Teixeira B, Maldonado A, D'Andrea P (2021) Composition and structure of the helminth community at rodents in matrix habitat areas of the Atlantic forest of southeastern Brazil. International Journal for Parasitology: Parasites and Wildlife 15: 278–289. https://doi.org/10.1016/j.ijppaw.2021.07.001

Manasyan YS (1985) To the study of the helminth fauna of the wood mouse *Apodemus sylvaticus* in the Armenian SSR. In: Kurashvili B (Ed.) IV Transcaucasian Conference on Parasitology. Tbilisi, June 1984, Metsniereba, 159–160. [In Russian]

Matsaberidze G (1966) Helminths of mouse-like rodents in regions of Kartli. Parasitological collection issue 1: 65–90. [In Georgian]

Matsaberidze G (1966a) Helminths of micromammals of Eastern Georgia. Ph.D. Thesis. Institute of Zoology of Georgia SSR. Tbilisi, Georgia. [In Russian]

Matsaberidze G (1976) Helminths of the micromammals of Georgia. Metsniereba, Tbilisi, 235 pp. [In Georgian]

Miller AL, Olsson GE, Walburg MR, Sollenberg S, Skarin M, Ley C, Wahlstrom M, Hoglund J (2016) First identification of *Echinococcus multilocularis* in rodent intermediate hosts in Sweden. International Journal for Parasitology: Parasites and Wildlife 5(1): 56–63. https://doi.org/10.1016/j.ijppaw.2016.03.001

Nakao MY, Yanagida TO, Okamoto M, Knapp J, Nkouawa A, Sako Y, Ito A (2010) State–of the–art *Echinococcus* and *Taenia*: Philogenetic taxonomy of human-pathogenic tapeworms and its application to molecular diagnosis. Infection, Genetics and Evolution 10(4): 444–452. https://doi.org/10.1016/j.meegid.2010.01.011

Nikolaishvili K, Lomidze T, Murvanidze L, Arabuli L, Asatiani K (2022) The case of detecting cestodes in mole-rat *Nannospalax xantodon* in Georgia. Bulletin of the National Academy of Sciences of Georgia 16(1): 69–75.

Pavlović I, Gavrilović P, Zdravković N, Stanojević S, Vojinović D, Kureljušić J (2021) The first record of *Molineus patens* (Dujardin, 1845) in foxes (*Vulpes vulpes* L.) in Serbia and Western Balkans. Veterinarska Glasnik 75(1): 69–75. https://doi.org/10.2298/VETGL.200517018P

Petrov AM (1941) Helminth Infection of Fur-Bearing Animals. International books, Moscow, 227 pp. [In Russian]

Ranjbar MJ, Sarkari B, Mowlavi GR, Seitollahi Z, Moshfe A, Abdolahi Khabisi S, Mobedi I (2017) Helminth infections of rodents and their zoonotic importance in Boyer-Ahmad District, Southwestern Iran. Iranian Journal of Parasitology 12(4): 572–579.

Rodonaia T (1951) Materials for the study of the helminths fauna of carnivora mammals in Georgia. Proceedings of the Institute of Zoology of the Academy of Sciences of the GSSR 10: 121–144. [In Georgian]

Rodonaia TE (1956) Helminths fauna of wild mammals of the Lagodekhi nature reserve. Proceedings of the Institute of Zoology of the Academy of Sciences of the GSSR 14: 147–187. [In Georgian]

Rodonaia T (1966) Helminths of hunting and commercial mammals of Eastern Georgia. Parasitological collection 1:91-142. [In Georgian]

Rodonaia T (1971) Helminths of hunting mammals of Georgia. Metsniereba, Tbilisi, 452 pp. [In Georgian]

Ryzhikov KM, Gvozdev EV, Tokobaev MM, Shaldybin LS, Matsaberidze GV, Merkusheva IV, Nadtochiy EB, Khokhlova IG, Sharpilo LD (1978) Key to helminths of rodent fauna of the USSR. Cestodes and trematodes. Nauka, Moscow, 232 pp. [In Russian]

Ryzhikov KM, Gvozdev EV, Tokobaev MM, Shaldybin LS, Matsaberidze GV, Merkusheva IV, Nadtochiy EB, Khokhlova IG, Sharpilo LD (1979) Key of helminths of rodent fauna of the USSR. Nematodes and acanthocephales. Nauka, Moscow, 272 pp. [In Russian]

Schidlovsky MV (1964) Mammals of the fauna of the highlands of the Greater Caucasus and Georgia. In: Kobakhidze D (Ed) Fauna of the highlands of the Greater Caucasus. Tbilisi, Publishing House of the Academy of Sciences of the GSSR, Tbilisi, 175–198. [In Russian]

Shakhtakhtinskaya ZM, Mustafaev YS, Sailov DI (1970) On helminthes of some lagomorphs and rodents of Azerbaijan. Scientific Notes of the Azerbaijan University, Series of Biological Sciences 1: 31–35. [In Russian]

Shimalov VV, Shimalov VT (2001) Helminth fauna of the stoat (*Mustela erminea* Linnaeus, 1758) and the weasel (*M. nivalis* Linnaeus, 1758) in Belarussian Polesie. Parasitological Research 87(8): 680–681. https://doi.org/10.1007/s004360000373

Stieger C, Hegglin D, Schwarzenbach G, Mathis A, Deplazes P (2002) Spatial and temporal aspects of urban transmission of *Echinococcus multilocularis*. Parasitology 124: 631–640. https://doi.org/10.1017/S0031182002001749

Tarzhimanova RA (1970) Towards knowledge of the helminth fauna of rodents in the Azerbaijan SSR – Research of helminthology in Azerbaijan. ELM, Baku, 177-182. [In Russian]

Ukleba D (1981) Landscapes of Georgia. In: Abashidze I (Ed.) Georgian Soviet Encyclopedia. Georgian SSR. Tbilisi, 27–28. [In Georgian]

Varodi EI, Malega AM, Kuzmin YI, Kornyushin VV (2017) Helminths of Wild Predatory mammals of Ukraine. Nematodes. Vestnik zoologii 51(3): 187–202. https://doi.org/10.1515/vzoo-2017-0026

Vlasov EA, Malisheva NS, Krivopalov AV (2015) Helminth fauna of Myomorph Rodents (Rodentia, Myomorpha) in the Central Chernozem state nature reserve. Russian Journal of Parasitology 4: 24–33. https://doi.org/10.12737/17327